March 18, 1958 H. F. PRASSE ET AL 2,827,373

Ni-Cr-Co-Mo VALVE SEAT INSERT

Filed Oct. 7, 1954

Fig. 1

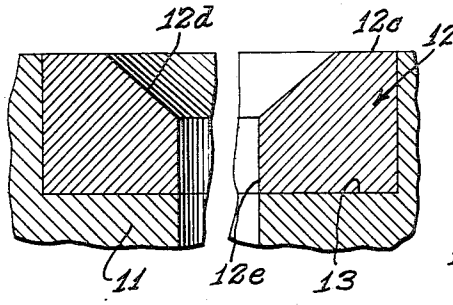


Fig. 2

PRIOR ART

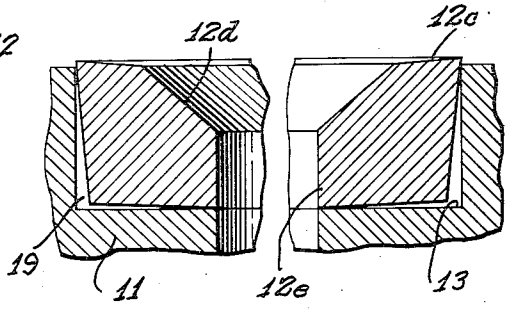


Fig. 3

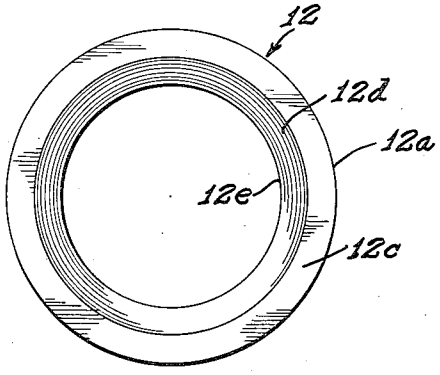


Fig. 4

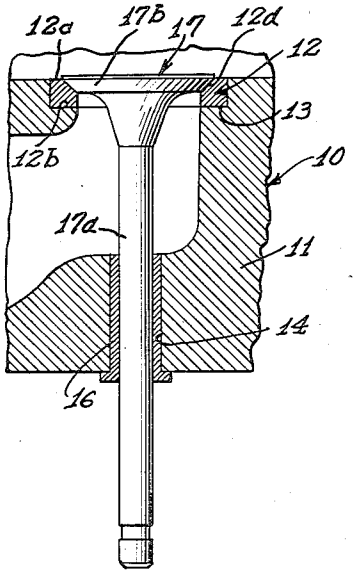
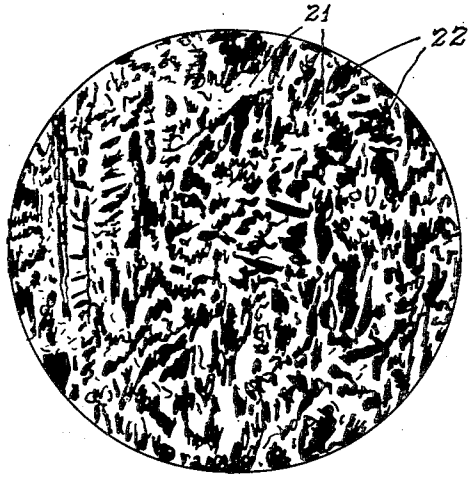


Fig. 5



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Ni-Cr-Co-Mo VALVE SEAT INSERT

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2 Claims. (Cl. 75—134)

The present invention relates to valve seat inserts of the type employed in internal combustion engines.

While the valve seat insert is a relatively simple structure from a mechanical point of view, the metallurgical problems presented in attempting to provide a completely suitable valve seat insert for modern engines employing leaded gasolines are very substantial.

One of the primary problems in the selection of a suitable metal or alloy for use in valve seat inserts arises from what is known as "collapse" resistance.

It is known that when metals or alloys are heated to very high temperatures for extended periods of time, they will congeal or set in an expanded state and will not contact to their original dimensions when cooled. Since engine valve seat inserts are normally press-fitted in recesses in engine cylinder heads or blocks, the valve seat inserts become heated in the operation of the engine and may expand to a point where further expansion is restricted by the cylinder metal itself. When this point is reached, continued expansion due to increased temperatures will cause the inserts to bow inwardly away from the restraining shoulder or wall of the engine head or block. If the bowed inserts reach the setting temperature and are then cooled from this temperature, the insert metal shrinks away from the insert recess and the insert becomes loose in the engine. The bowed and set inserts are known as "collapse" inserts and the temperature at which such inserts take a permanent set is known as the "collapse" temperature.

In the past, valve seat inserts for the most part have been produced by expensive forging, machining and heat treating procedures. The best of these prior known inserts had to be annealed, hardened, quenched, tempered and drawn to a Rockwell hardness of about 35 on the C scale.

The microstructure of these inserts was generally an aggregate of carbides with some martensite oriented in an interdendritic pattern and having some of the carbides in the grain boundaries and scattered throughout the matrix. This structure however, did not provide adequate collapse resistance at temperatures above about 800° F. Since modern, high speed, high compression internal combustion engines frequently operate at temperatures which would cause the valve seat inserts to rise above 800° F., collapsed inserts have presented a serious engine problem.

Another problem which manifests itself particularly in engines employing gasolines having a relatively high percentage of tetraethyl lead is that of the valve seat insert surface resistance. A good insert must have a smooth face which resists deposit build up, corrosion, erosion, pitting, or excessive wear. Otherwise, an unsatisfactory seal will result between the valve seating face and the valve seat insert ring.

A characteristic possessed by a good valve seat insert ring is that of lack of affinity for combustion chamber deposits. If the insert has an affinity for the carbonaceous materials and lead residue present in the combustion chamber, the materials will become deposited on the

insert ring and will act as effective heat dams, thereby increasing the valve head temperatures.

In line with the above, a good valve seat insert should also maintain its hot hardness properties, i. e., it should retain a substantial amount of its hardness even at the elevated temperatures at which the engine is operating. This ability to maintain its hardness governs to a large extent the degree of contact which can be maintained between the valve face and the valve seat insert at the operating temperatures of the engine.

The characteristics of the valve seat insert also have a pronounced effect upon the valve lash changes evident during operation of the engine. These changes accumulate in the valve train due to wear and the pounding down of the valve seat insert during use. It is desirable that the valve seat insert have characteristics which minimize these changes, as it is undesirable to make frequent adjustments on the valve lash during operation of the engine.

All of the above factors indicate that the problem of selecting a suitable alloy for valve seat insert rings is quite substantial. The selection of a suitable valve seat ring in the past has frequently been a compromise between several of these factors. In other words, some materials which were satisfactory from the standpoint of resistance to pitting, may not be acceptable because the valve seat ring tends to collapse at comparatively low temperatures. On the other hand, valve seat rings which may be satisfactory from the standpoint of their resistance to collapse may have an affinity for combustion chamber deposits which would render them unsatisfactory for this type of use.

In view of the foregoing, the need still remains in the art for a more satisfactory valve seat ring and the satisfaction of that need is the primary object of the present invention.

Another object of the present invention is to provide an improved valve seat insert ring which is less expensive and more convenient to manufacture than the type of valve seat insert ring being presently employed in many types of internal combustion engines.

Other and further objects of this invention will be apparent to those skilled in the art from the following detailed description of the annexed sheet of drawings, which by way of example only, illustrates a valve seat insert of this invention.

On the drawings:

Figure 1 is an enlarged, fragmentary view of the valve port area of an internal combustion engine showing the valve seat insert in its normal condition;

Figure 2 is a view similar to Figure 1 and illustrates the insert in a "collapsed" condition;

Figure 3 is a plan view of the insert;

Figure 4 is a fragmentary, cross-sectional view, with parts in elevation of the valve port area of an internal combustion engine equipped with a valve seat insert of this invention; and

Figure 5 is a graphic reproduction of the microstructure of the alloy constituting the insert, at a magnification of about 500 times.

As shown on the drawings:

From Figures 1 to 4, it will be seen that the engine valve port assembly 10 may include an engine block or cylinder head 11 normally composed of cast iron, and a cast valve seat insert 12 pressfitted into a recess 13 of the engine block 11. A bore 14 concentric with the recess 13 is provided to receive a valve stem guide 16 in the usual manner. A valve 17 is shown in seated relation in the valve seat insert ring 12 (Figure 4), the valve 17 having a stem 17*a* slidably received within the valve stem guide 16.

The valve seat insert 12 may consist of a ring hav-

ing a cylindrical outer peripheral wall 12*a*, a flat bottom 12*b*, a flat top 12*c* and a tapered seating face 12*d* converging from the flat top 12*c* to a cylindrical inner peripheral wall 12*e*.

The peripheral wall 12*a* is in snug fitting relation with the vertical wall of the recess 13 and is preferably press-fitted or shrinkfitted into the recess 13 with the flat bottom 12*b* of the insert being seated upon the bottom of the recess 13.

As evident from Figure 4, the tapered seating face 12*d* is arranged to receive the tapered seat 17*b* on the valve 17.

As evident from Figure 1, in normal operation the valve seat insert 12 maintains its tight fit in the recess 13 and expands to substantially the same degree as the metal in which the recess 13 is formed. However, when the valve seat insert 12 is heated to a point where it can expand no further due to the restraining effect of the walls of the recess, it may become bowed as shown in Figure 2. This bowing may create a gap illustrated at 19 in an exaggerated form in Figure 2. If the insert 12 sets or "collapses" in the condition shown in Figure 2, then the gap 13 will remain void under lower operating temperatures. As a result, the insert 12 will remain loose in the recess 13.

We have now found that the "collapse" temperature of valve seat inserts can be increased as well as enhancing other desirable properties of the inserts by employing a cast valve seat insert having the following composition:

	Percent
Carbon	2.25 to 2.75
Nickel	35 to 40
Chromium	32 to 38
Cobalt	10 to 14
Molybdenum or tungsten, or mixtures of the two	6 to 8
Iron	maximum 8.0

A particularly preferred composition for valve seat insert rings is the following:

	Percent
Carbon	2.5
Nickel	37.5
Chromium	35.0
Cobalt	12.0
Molybdenum	7.0
Iron	6.0

For the purpose of this invention molybdenum and tungsten are substantially interchangeable. Where the hardness of the insert is of prime importance tungsten alone may be employed, but where toughness is the objective molybdenum alone will be used. If desired, a mixture of the two metals may be used to secure the benefit of both metals.

Another very suitable composition is the following:

	Percent
Carbon	2.60
Nickel	35.0
Chromium	37.0
Cobalt	12.0
Tungsten	8.0
Iron	5.4

The following is an example of an alloy containing both tungsten and molybdenum.

	Percent
Carbon	2.50
Nickel	35.5
Chromium	38.0
Cobalt	11.0
Molybdenum	3.5
Tungsten	3.5
Iron	6.0

The alloys of the above compositions may be melted and cast in suitable molds for producing the insert ring 12. The casting process employed may include conventional sand casting, shell molding, investment casting, or other casting techniques capable of producing smooth, accurate castings free from cracks, blow holes, shrinks and the like. The cast insert rings need no special heat treatment, making them considerably easier and less expensive to manufacture than commonly used insert rings which require hardening and drawing treatments incident to their manufacture.

The microstructure of the finished valve seat insert rings is illustrated in Figure 5 of the drawings. It will be observed that the structure may include relatively small dendrites 21 surrounded by a solid solution 22 consisting of a eutectic matrix.

A convenient "collapse" test for the rings consists of inserting the ring under test in a cast iron cup receiving a high frequency induction coil in the hollow interior of the ring. The cast iron cup is surrounded by a water ring. The insert is then intermittently heated by the induction coil and cooled by a water spray on the cast cup. The insert is heated first to about 300° F. for several hundred cycles of operation. It is then cooled and checked for looseness. The temperature is then increased in 25° increments and the heating is repeated for several hundred cycles. The procedure is continued until the insert under test loosens in the cast iron cup. The final temperature is then recorded as the loosening temperature or "collapse" temperature.

The "collapse" resistance of four insert rings having the composition within the ranges given previously was measured with the following results:

Initial Interference	Decrease Insert, O. D.	Decrease Insert, I. D.	Increase Fixture, I. D.	Cycles to Loosen	Final ° F. Temp.
.0029	.0033	.004	.0003	5,100	1,150
.0031	.0041	.004	.0002	5,400	1,175
.0030	.0040	.003	.0002	5,400	1,175
.0029	.0037	.004	.0001	4,500	1,100

The resistance of the insert rings to corrosion by lead oxide was determined in a standard test in which the samples are packed in lead oxide and maintained at a temperature of 1675° F. for 1 hour in an oxidizing atmosphere.

The decrease in weight after the test, expressed in grams per square decimeter, is taken as the lead oxide corrosion loss.

The results obtained from the samples of inserts produced according to the present invention are given below:

Oxidizing atmosphere—1 hour at 1675° F.

	Gm./sq. dm.
Sample #1	9.4
Sample #2	12.4
Sample #3	10.7
Average	10.8

In contrast, samples of various commercial valve seat inserts of compositions different from that of the present invention, exhibited lead oxide corrosion losses ranging from several times to 20 times as high as figures obtained in the foregoing test.

In addition to the foregoing, valve seat inserts made in accordance with the present invention did not accumulate a significant amount of combustion chamber deposits on their faces and evidenced only a slight loss in hardness at the operating temperature of the engine. This, again, was in marked contrast to several commercial valve seat inserts which have a substantially greater affinity for the combustion chamber deposits, and lost a significant amount of hardness at the operating temperature of the engine.

In most instances, there was no measurable change in the average hardness of the top of the insert, even after

the insert has been employed for 400 hours of cyclic operation in a heavy duty gasoline engine.

A very significant advantage of the present invention arises from the valve lash properties observed when valve seat inserts of the present invention are employed in operating engines. In one such test, a heavy duty truck engine was operated with three of its eight cylinders employing valve seat insert rings of the present invention.

In two of the cylinders, there was an average decrease in accumulated valve lash of less than 0.003 inch during 400 hours of operation. In the other cylinder employing the improved insert ring, there was an increase in the accumulated valve lash of 0.001 inch. Again, in contrast, a high nickel alloy, containing 58.7% nickel, 26% chromium, about 4% iron and 2.0% carbon exhibited a decrease of accumulated lash in excess of 0.010 inch for the same period of operation in the same engine.

From the forgoing, it will be appreciated that the valve seat insert of the present invention has exceptional resistance to collapse, resistance to lash loss, and excellent corrosion resistance. The additional properties of good hot strength and resistance to deposits make the alloys of the present invention considerably more satisfactory for the intended use than theretofore known more expensive inserts.

While the alloys of the present invention have properties making them particularly suitable in the manufacture of valve seat inserts, it will be appreciated that the alloy will have more general applicability for articles requiring wear and corrosion resistance properties.

It will be understood that modifications and variations may be effected without departing from the scope and novel concepts of the present invention.

We claim as our invention:

1. A valve seat insert for internal combustion engines

comprising a ring consisting essentially of the following composition:

	Percent
Carbon	2.25 to 2.75
Nickel	35 to 40
Chromium	32 to 38
Cobalt	10 to 14
Molybdenum	6 to 8
Iron	8.0 maximum

said composition having been cast and cooled to provide a cast structure including dendrites dispersed in a solid solution of a eutectic matrix.

2. A valve seat insert for internal combustion engines comprising a ring consisting essentially of the following composition:

	Percent
Carbon	2.50
Nickel	37.5
Chromium	35.0
Cobalt	12.0
Molybdenum	7.0
Iron	6.0

said composition having been cast and cooled to provide a cast structure including dendrites dispersed in a solid solution of a eutectic matrix.

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